MICROCLIMATE OF A SPECIAL SHELTERBELT SYSTEM UNDER ARID SITE CONDITIONS IN HUNGARY

Honfy V[1*], Bakti B[1], Borovics A[2], Rásó J[1], Somogyi N[3], Keserű Z[1]

(1) Department of Plantation Forestry, NARIC Forest Research Institute, Püspökladány, Hungary (2) Department of Tree Breeding and Improvement, NARIC Forest Research Institute, Sárvár, Hungary (3) NARIC, Gödöllő, Hungary

*Corresponding author: honfy.veronika@erti.naik.hu

Abstract

In Hungary, agricultural land occupies cca. 60% of the land area. Of the arable land 85% can be found in agro-environmentally sensitive areas. In these areas the nutrient content is very low and floods and drought periods are very frequent. In 1998 a special shelterbelt system was established in Földes, under arid site conditions. Wind speed and soil moisture dynamics were monitored throughout 2017. The results show that changes in soil moisture content follow the pattern of the measured wind speed dynamics. The observations highlight the importance of shelterbelts, which can mitigate unfavourable site conditions, thus playing a crucial role to combat climate change.

Keywords: shelterbelt; drought; climate change; mitigation; soil moisture

Introduction

In Hungary, agricultural land (including crop and grasslands) occupy cca. 60% of the land area. Of the arable land 85% can be found in agro-environmentally sensitive areas. In these areas the nutrient content is very low and floods and drought periods are very frequent. Consequently we have to find the suitable growing technology that can provide the sustainable and profitable management under unfavourable site conditions.

The concept of agroforestry is rather new to Hungarian farmers and scientists. The Hungarian National Agricultural Research and Innovation Centre's (NARIC) Forest Research Institute (FRI) Department of Plantation Forestry started to study agroforestry systems and constructed its first trials in 2014. Since then further experiments have been set up and the institution has started to spread the knowledge of agroforestry, its characteristics and specialities, through agricultural and forestry forums and conferences, based on international literature, and examples. The aim is to establish trials across the whole country, to be able to study different sites where profitable plantation forestry and agroforestry technologies can be tested under the ecosystem of Hungary, providing models, and options to forestry and agriculture in marginal areas (Keserű et al. 2014).

Deflation is a serious problem in many arid areas of Hungary, as well as erosion in undulating areas where the soil is temporarily uncovered due to conventional agriculture. There is about 700 000 ha arable lands and 100 000 ha grasslands in Hungary with low agroecological potential, where production in the conventional way cannot be sustained (Borovics and Gyuricza 2015).

Agroforestry used to be a widespread technology of land use in Hungary during the past century. However during recent decades it has disappeared from large areas of the Hungarian countryside. The negative effects of climate change urge Hungary to address and find ways to adapt or to mitigate it. According to international literature, agroforestry systems significantly mitigate these negative effects. It is realized by excessive carbon sequestration per land unit. Agroforestry create favourable microclimate due to moderate radiation and higher relative humidity. The system's positive effects on biodiversity, water quality and soil protection (erosion, deflation) is significant as well. Shelterbelts can enhance resilient and sustainable management.

Materials and methods

In 1998 a proper agroforestry system was established in Földes by an organic farmer and beekeeper, Zsigmond Bíró and the Forest Research Institute, although that time agroforestry systems were barely presented in Hungary. The shelterbelt system was established in a 5.1 hectar organic agricultural field nearby Földes, where previously sugar beet was produced. The field characteristics are shallow site, meadow solonetz soil turning into steppe formation, with some periodic water effected area. The shape of the field is rectangular, divided into 3 parcels (80m x 80m, 80m x 80m, 80m x 120m) by the shelterbelt, so that the arable lands are surrounded with trees from all the 4 sides (Figure 1). The trees were planted in 8 rows, interrow spacing was 3 m and in-row spacing was 1 m, making up to 20 m each stripe, covering altogether 3 ha. The tree height varies between 15 and 20 meter in the shelterbelts.

Shelterbelts are significant in domestic honey production too. Valuable bee pastures can be established by choosing the species with good care, which provide pollens and nectar for bees (Keresztesi and Halmágyi 1975). The species used in the shelterbelt were originally chosen according to their significance to apiculture. There were determined by their blooming period to continuously provide pollen and nectar for the bees, and also to fulfill windbreak characteristics. Therefore application of shelterbelts can address some of the challenges that apiaries face and it also effects on carbon fixing advantageously, compared to the monocultural cultivation of plants.

Figure 1: Aerial photograph of the shelterbelt system in Földes, Hungary

Wind speed measurement

Repeated, point-like measurements were used to determine the wind speed reduction of shelterbelts. At four elevations were measured the temperature, relative humidity, wind direction and wind speeds of 35 cm, 70 cm, 100 cm, 135 cm using a mobile measuring device (EMOS digital meteorological station).

Soil moisture measurement

For the test, the soil moisture/soil resistance meter OT 001 was used to measure soil moisture and soil temperature by 1 cm in depth of 0 to 80 cm.

Results

Given an irrigated area surrounded by shelterbelts, the speed of replacement of humid air mass slows down, allowing a reduction of water used for irrigation. In the wintertime, snowdrift doesn't take place in these protected areas, so the soil doesn't get frozen in the deeper layers, only in the surface. The soil starts defrosting about the same time as the snow starts melting, so the majority of the precipitation can be absorbed by the soil (Frank and Takács 2012). Reducing evaporation is also important to prevent secondary salinisation (Tóth et al. 1972).

Windspeed was recorded before end during the vegetation period, when trees were in foliage, and when leafless (Figure 2 and 3).

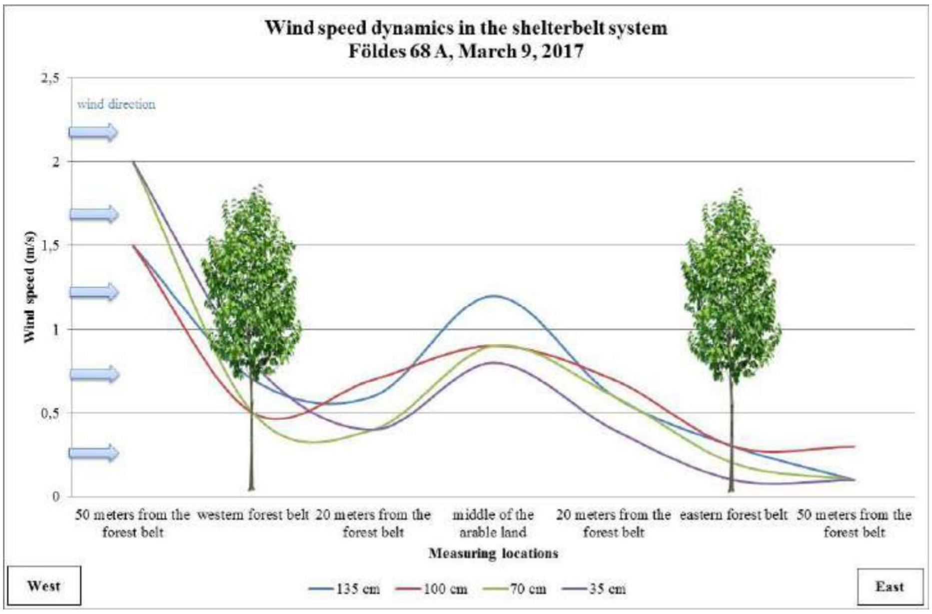

Figure 2: Wind speed dynamics in the shelterbelt system under leafless conditions.

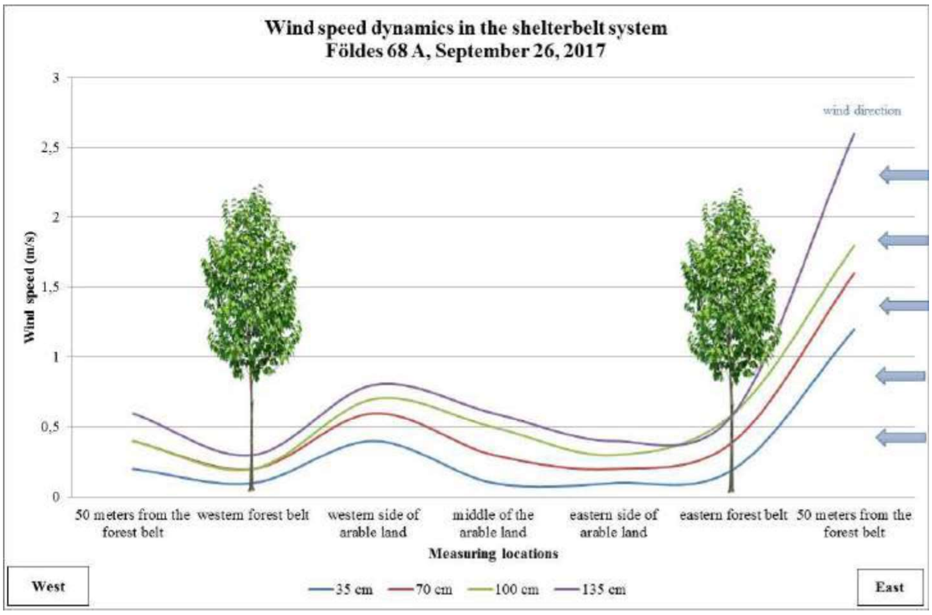

Figure 3: Wind speed dynamics in the shelterbelt system under foliage conditions.

The changes in soil moisture content are determined by the increasing water uptake of the shelterbelt. Soil moisture was measured in seven fixed locations in every 5 cm depth up to 30 cm (Figure 4).

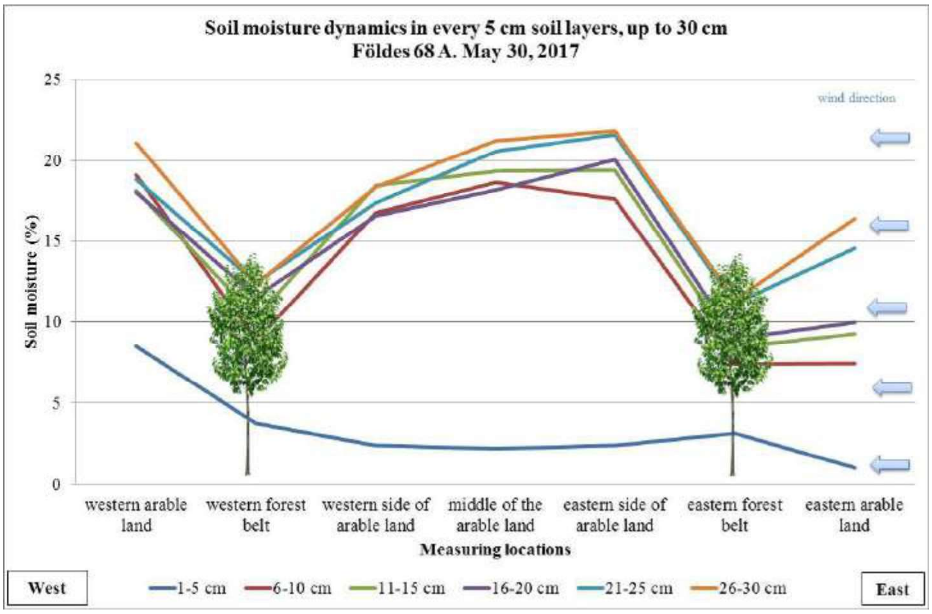

Figure 4: Soil moisture dynamics in the shelterbelt system.

The results show that changes in soil moisture content follow the pattern of the measured wind speed dynamics which is realized in higher yield. The above discussed investigations highlight the importance of shelterbelts, which can mitigate unfavourable site conditions, thus playing a crucial role to combat climate change.

Discussion

The value of the above discussed site has only been recognized recently, therefore further data acquisition, studies and researches are needed. We assume that the abundant blooming species in the shelterbelt with its increased surface exposed to full sun provides more flowers and more intense blooming throughout the vegetation period, resulting in a high value bee pasture serving increased amount of pollens and nectar.

One of the most effective ways to protect soil from degradation is the application of shelterbelts. The speed of the wind is decreased at the protected side of the field; therefore the wind's drying affect gets reduced at the surface of the soil. By decreasing the velocity of the wind, evapotranspiration is also moderated, the dispersion of precipitation is balanced, hence soil moisture is increased and all these effects can contribute to higher yields.

Acknowledgments

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References

Borovics A, Gyuricza Cs (2015) Produce together with nature (in Hungarian). Agroforestry in focus. Agroinform 11: 12-17.

Frank N, Takács V (2012) Windbreaks and shelterbelts examination by their effect on decreasing the windspeed. Bulletin of Forestry Science 2 :151-162 p. (in Hungarian).

Keresztesy B, Halmágyi L (eds) (1975) The beepasture. Academic Publisher, Budapest, 791 p. (in Hungarian)

Keserű Zs, Csiha I, Rédei K, Kamandiné Végh Á, Kovács Cs, Rásó J (2014) Environment friendly and cost-effective agro-forestry systems, as land-use options for the future. Association for Lowland Forests 70-75 (in Hungarian).

Tóth B et al. (1972) Afforestation on salt effected soils. Academic Publisher, Budapest.